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A CROSS-DOCKING ANALYSIS AT 25 CFSD

by

Major Doug Hoyle

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ABSTRACT

The problem of identifying an appropriate cross-docking strategy for 25 Canadian Forces Supply Depot (CFSD) was investigated. Potential cross-docking strategies were developed and evaluated. Employing 1995 supply transaction data, simulations were conducted to identify the impact of the cross-docking strategies on 25 CFSD. It was concluded that cross-docking is not practical at 25 CFSD due to infrequent cross-docking opportunities and physical limitations at the depot which reduce the efficiency of cross-docking.

RÉSUMÉ

Le problème de l'identification d'une stratégie de transbordement appropriée a été analysé. Des stratégies potentielles ont été développées et évaluées. Avec l'aide de données d'approvisionnement de 1995, des simulations ont été effectuées pour identifier l'impact des stratégies de transbordement sur le 25 DAFC. Elles ont révélé que le transbordement n'est pas pratique au 25 DAFC à cause de la faible incidence des occasions de transbordement et des limitations physiques du dépôt qui réduisent l'efficacité du transbordement.

TABLE OF CONTENTS

PAGE

Abstract i

Table of Contents ii

Acronyms iii

I. Introduction 1

II. Cross Docking 2

III. Analysis Methodology 4

IV. Material Processing at 25 CFSD 5

V. Cross-Docking at 25 CFSD 8

VI. Cross-Docking Strategies 11
- Full Cross-Docking 12
- High Priority PDO Cross-Docking 12
- Large Weight, Volume, or Quantity 13
- Total Quantity PDO 14

VII. Simulation Results 14

VIII. Conclusions 18

IX. References 20

Annex A - Material Priority Codes [9] A-1

Annex B - Simulation Algorithm B-1

ACRONYMS

CF	Canadian Armed Forces
25 CFSD	25 Canadian Forces Supply Depot
CFSS	Canadian Forces Supply System
DND	Department of National Defence
MPC	Material Priority Code
PDO	Posted Due Out
WMIS	Warehouse Management Information System

CROSS-DOCKING ANALYSIS FOR 25 CFSD

I. INTRODUCTION

1. The Canadian Forces (CF) has an extensive supply system which is used to support and sustain the wide variety of activities within the CF. Supply Depots form a very important part of the Canadian Forces Supply System (CFSS). Depots perform two functions. They are the primary means of receiving new material into the CFSS and they warehouse a large portion of the CF's material assets. Recently the number of depots has been reduced from four to two. Due to the increased workload placed upon the remaining depots, improved productivity has become a primary concern. To help 25 Canadian Forces Supply Depot (25 CFSD) accommodate it's increased warehousing and distribution workload it was provided with a new facility which has state of the art warehousing and management information systems (WMIS).

2. In June 1995, the Directorate of Supply Resources and Operations (DSRO) requested that D Log A provide assistance to 25 CFSD. The aim was to find ways to increase the productivity of the depot. It was generally felt that the depot could be more productive but it was difficult to identify what needed to be changed. Visits to the depot and subsequent investigations resulted in several projects being initiated by D Log A on behalf of 25 CFSD [1].

3. One of the issues raised by the depot staff was cross-docking. Cross-docking has been employed in commercial warehousing operations with significant improvements in productivity [2]. It was assumed that cross-docking could help 25 CFSD increase it's productivity but no one could quantify the affect that cross-docking would have on the depot. Cross-docking has also been labelled " a Venus Fly Trap - something one feels an irresistible

urge to get into, but once they do they are eaten alive " [3]. Because of these concerns, D Log A was asked to study the impact of implementing cross-docking at 25 CFSD and to recommend an appropriate cross-docking strategy [4]. During the conduct of the study, D Log A was re-organized. It is now LOGORT.

II. CROSS-DOCKING

4. Cross-docking is defined as "the expedited flow of goods from receipts to shipping" [5]. Material is received at a warehouse and passed directly to the issues section bypassing the warehousing process completely. Due to it's shorter material handling process, cross-docking can significantly reduce warehousing costs and improve customer service. The ideal cross-docking operation allows large shipments to be received, broken down into smaller shipments and loaded onto transport for forwarding to the destination in minimum time. All warehousing functions are bypassed when this is possible. Unfortunately not all material that is received at a warehouse may be suitable for cross-docking. For instance material being received must have a destination assigned to it before it can be cross-docked. Material being held as stock cannot be cross-docked. Therefore cross-docking is seldom used as the sole material processing method in a warehouse.

5. In order to accomplish efficient cross-docking, two elements must be present in the warehousing operation: a comprehensive material information system, and an adequate warehouse configuration [6]. The management information system requires the ability to identify what quantities of shipments are due out[1] to customers before the shipment arrives. This is necessary to allow the identification of material that is cross-dockable early in the receipts process. The warehouse must be configured to provide the sufficient space and a suitable layout to physically allow cross-docking to be practised. Cross-docking typically requires shipments to be deconsolidated and formed into customer shipments during the receipts process to allow cross-docking. Deconsolidation is not normally performed in the

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1 In the CFSS this is referred to as Posted Due Out (PDO). A PDO occurs when all national stock of an item is depleted and subsequent demands for it cannot be satisfied immediately. These unsatisfied demands are queued in the national inventory management system creating PDO's. Once new stocks of the item arrive, issue instructions are created automatically to satisfy the pending demands.

receipts area so space is not usually allocated for it. One other factor that affects the success of cross-docking is the type of material being processed. It should be characterized by large receipt shipments, high portions of receipts PDO and material that is easily deconsolidated and re-shipped. Unfortunately pure cross-docking is seldom possible due to the absence of one or more of these elements or inappropriate shipment characteristics. As the actual warehousing operation varies from the ideal cross-docking operation, the benefits of cross-docking are diminished.

6. Cross-docking has existed in commercial warehousing and distribution systems for many years. Some distribution warehousing operations have been able to cross-dock up to 70% of all volume received [7] resulting in up to 30% productivity increases in their warehousing operations [8]. There are two changes in the market place which have contributed to the increased interest in cross-docking from other sectors. Recently it has been acknowledged that logistics plays a significant role in determining the overall efficiency of most operations. This has led to a greater interest in efficient logistics practices. Re-engineering of logistics systems has allowed practices such as cross-docking to be incorporated. The other change in market conditions has been the increased emphasis upon customer service. The shorter material handling process offered by cross-docking provides an opportunity to improve customer service. The impressive gains in productivity acquired through cross-docking and the improved customer service have combined to attracted the interest of operations that are not traditional users of cross-docking. The result has been a great increase in the practice of cross-docking.

7. Traditionally, the Department of National Defence (DND) has not employed cross-docking at its depots. The changes in market conditions that have led to the increased interest in cross-docking in the civilian sector are mirrored in DND. Additionally DND has been attempting to identify new business practices that can allow the military to operate more efficiently. Therefore it is logical to consider cross-docking at the supply depots. 25 CFSD was considered a good candidate for this analysis due it's recent modernization. The new depot with it's modern material handling equipment and WMIS appeared to offered the best conditions for cross-docking among DND depots.

III. ANALYSIS METHODOLOGY

8. The aim of the analysis was to identify the impact that cross-docking would have on 25 CFSD. In order to satisfy this aim, the current material handling process was examined. This analysis allowed the development of a material processing map which is explained in section IV. Analysis of the process map and a review of cross-docking literature allowed an identification of the likely impact that cross-docking would have at 25 CFSD. This work is summarized in section V along with a material processing map for 25 CFSD under cross-docking. Analysis of supply transaction histories from 25 CFSD and the cross-docking material processing map revealed several potential cross-docking strategies which are explained in section VI. A simulation of the depot operations under the different cross-docking strategies was conducted. The simulation was conducted using Pascal source code which read supply transaction data, employed the selected cross-docking rule and determined the cross-docking activity levels that were achieved. An explanation of the simulation algorithm is included as Annex B. The results of the simulations using the various cross-docking strategies were analyzed to identify characteristics and trends. The results are contained in section VII. Conclusions regarding cross-docking at 25 CFSD were created based upon the results and are summarized in section VIII.

9. The supply transaction data used for this study was acquired from queries of the CFSS transaction history database. This database retains records of all transactions performed by Canadian Forces Supply entities on the CFSS. Since every PDO receipt at 25 CFSD is considered a cross-docking opportunity, PDO records were of prime concern. Unfortunately, the CFSS computer system does not retain records of PDO receipts. In order to identify cross-docking opportunities from the available data, a surrogate to PDO was developed. It was assumed that anytime the CFSS computer system was advised of an item's arrival at 25 CFSD and the depot was subsequently advised by the CFSS computer system to issue that item to a customer within one working day, the item was PDO when received. This assumption was the basis of the algorithm used in the simulation to identify PDO receipts. Although this assumption is not universally true [2], it was considered a sufficiently close approximation of PDO's for the purpose of the analysis. The queries on the CFSS transaction

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[2] It is possible for a customer to place a demand on the CFSS for an item during the day that the item is arriving at the depot. In this instance the selected rule would identify a PDO when one did not exist. This is a relatively infrequent occurrence.

database captured all receipt and issue transactions for account 1B (25 CFSD) for the calendar year 1995.

10. Members of the staff at 25 CFSD expressed concern that the 1995 transactions might provide misleading results due to the depot consolidation project that was being conducted during that year. The closure of two other depots during 1995 meant that many shipments of supplies from the closing depots were being received at 25 CFSD. These receipts of stock from other depot were assumed to be less prone to back orders since the items had been available for issue to customers prior to their transfer to 25 CFSD. To test this theory, simulation runs were performed which ignored receipts of material from other DND units.

IV. MATERIAL PROCESSING AT 25 CFSD

11. There are three main functions performed at 25 CFSD; receipts, warehousing, and issues. Material is processed sequentially by each of the functional groups during it's stay at the depot. Each of the functions in the process flow is characterized by several steps. Figure 1 depicts the normal process flow of material at the depot through the steps of each functional group.

a. Step 1.1 Receive. Material is delivered to the loading docks by civilian suppliers or military agencies. It is off loaded and deconsolidated.

b. Step 1.2 Verify. Material is verified against its documentation to confirm that the condition, quantity and identity of the material is correct.

c. Step 1.3 Record. Computer transaction(s) are completed to adjust the inventory records in the CFSS.

d. Step 1.4 Prepare Material. A barcode sticker is printed and affixed to the material. The weight and volume of the material is measured and recorded on the WMIS.

e. Step 1.5 Forward Material. Material is passed to the warehouse section for storage using the monorail train system for small items or forklifts for large items.

f. Step 2.1 Store. Material is placed in predetermined storage location(s) depending upon the size and characteristics of the items.

g. Step 2.2 Maintain. Stocktakings, condition verifications and stock rotations are performed on the items while in the warehouse.

h. Step 2.3 Retrieve. Responding to customer demands, desired items are retrieved from stock locations.

j. Step 2.4 Forward Material. Material is passed to the issues section using the monorail system for small items and forklifts for large items.

k. Step 3.1 Document. Issue and shipping documentations are prepared for the material.

m. Step 3.2 Consolidate. Items destined for the same geographic area are consolidated.

n. Step 3.3 Load. Consolidated shipments are loaded onto transport for delivery to customers.

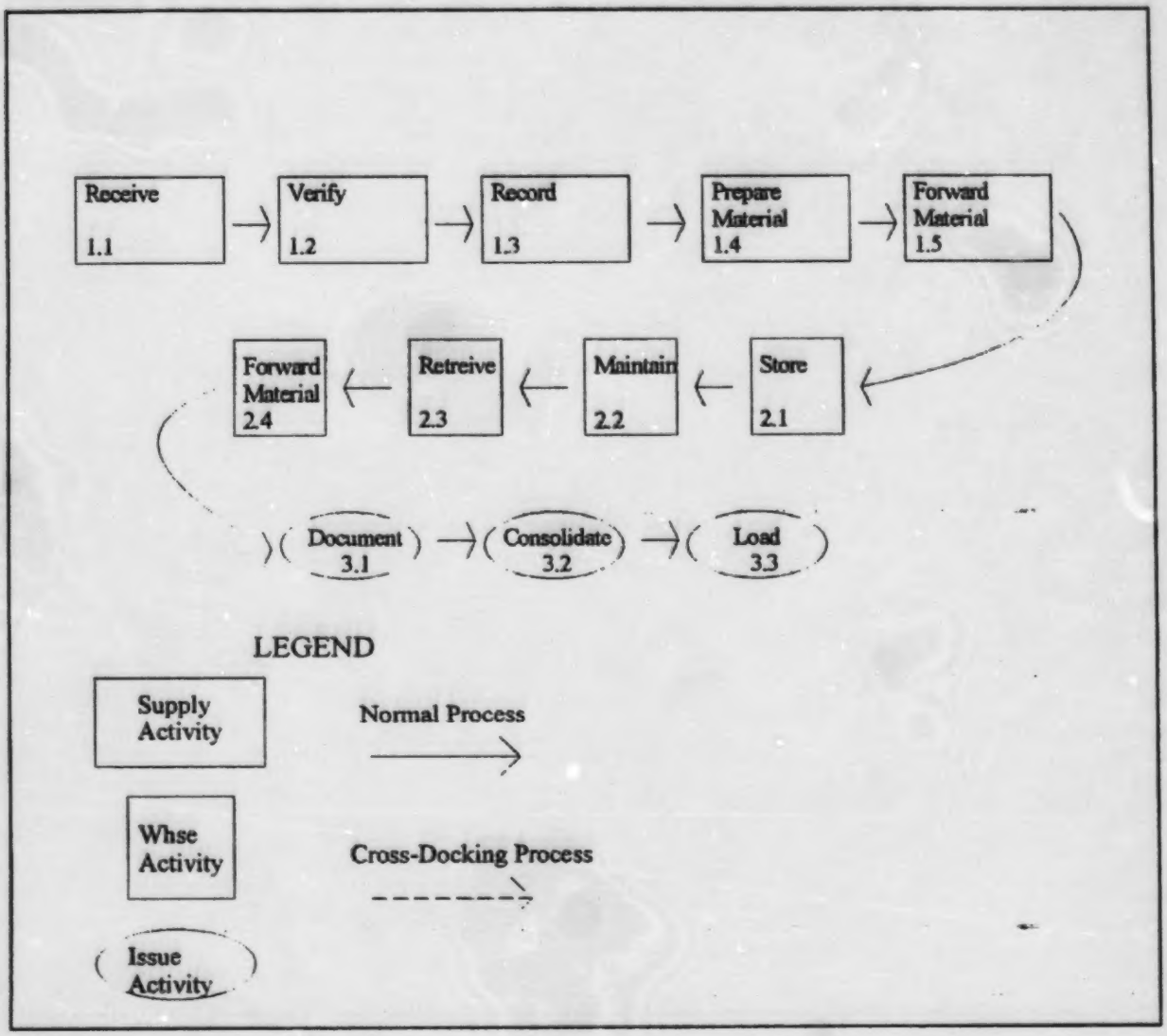

Figure 1: 25 CFSD Current Material Handling Process

12. This process is currently employed, with very few exceptions, for all material at 25 CFSD. It works well for the majority of the material which will reside at the warehouse for some duration. This process is inefficient for material which is PDO to a customer when it is received at the depot. These items must pass through several non-value added processing steps before the customer receives the desired item. These extra steps delay delivery and waste depot resources. Cross-docking is an abbreviated material handling process for PDO material which alleviates these problems.

V. CROSS-DOCKING AT 25 CFSD

13. Figure 2 illustrates the ideal process for cross-docking of material. The material handling process is reduced from the twelve step process shown in Figure 1 to a seven step process. This represents a significant savings in material handling resources. The ideal cross-docking process is only applicable to cross-dockable material. Other material must be handled differently. Therefore this process is seldom practised in isolation.

14. The institution of cross-docking at 25 CFSD would dramatically change the flow of material that currently exists. Only a portion of the material received is cross-dockable therefore two material processing systems would need to be practised concurrently, one process for the regular receipts and one process for cross-dockable receipts. Figure 3 illustrates the two different process flows. The initiation of cross-docking would require some changes to the procedures followed in each of the steps for all material. As an example, during step 1.2 computer queries for all receipts would have to be processed to identify PDO quantities and destinations for the shipment. During step 1.3 material used to satisfy PDO demands would have to be diverted from the remaining shipment. The PDO quantity would immediately be forwarded to the issues section while the remaining quantity would be processed in the regular manner. Cross-docked material arriving at the issues area could often have a longer wait during step 3.2. The CFSS selects its method of shipping material according to the urgency of the requirement for the material. Low priority material is consolidated and shipped to each geographic region once a week. Under the current material handling process low priority material is taken from the warehouse on the day it is scheduled to be shipped. Therefore low priority cross-docked material which arrives at the shipping section on the wrong day could remain in the issues section for up to six days awaiting transport.

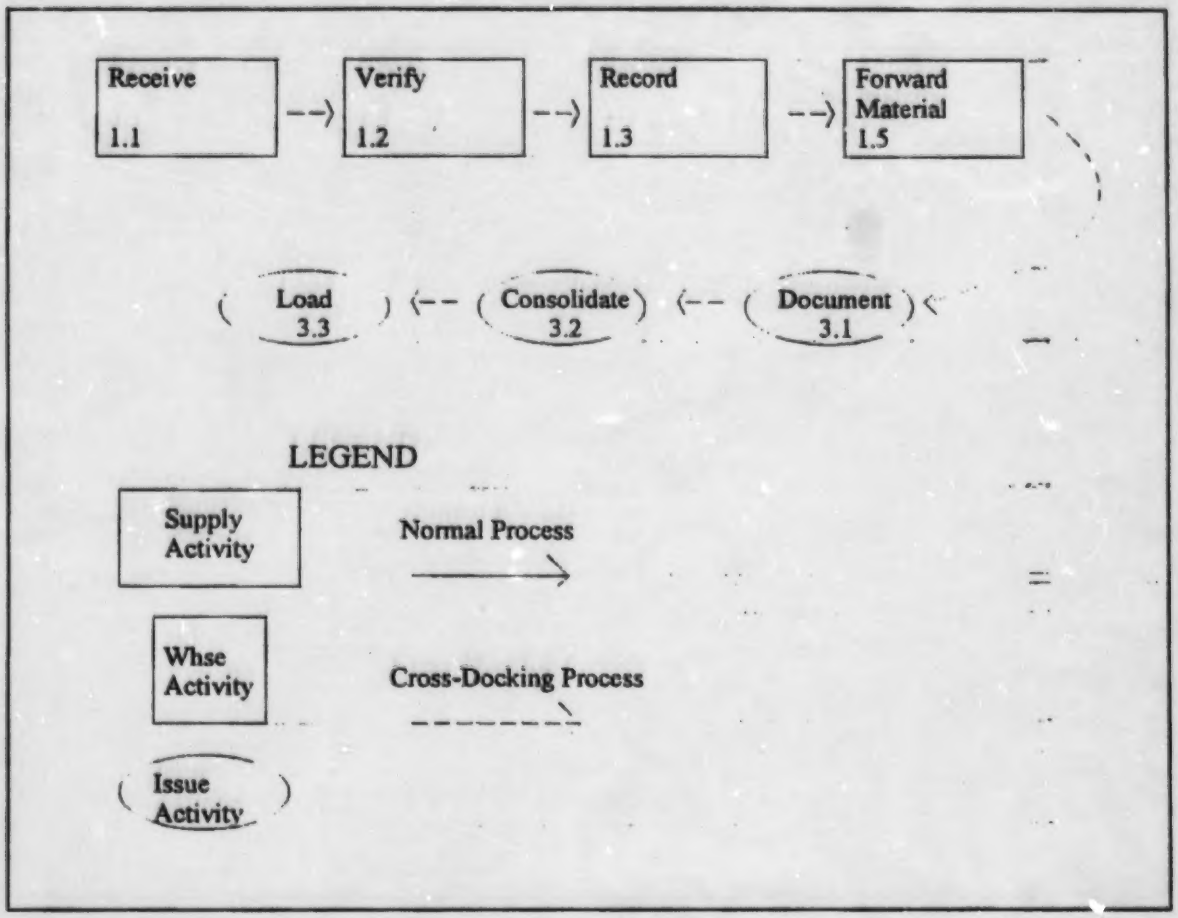

Figure 2: Ideal Cross-Docking Process Flow

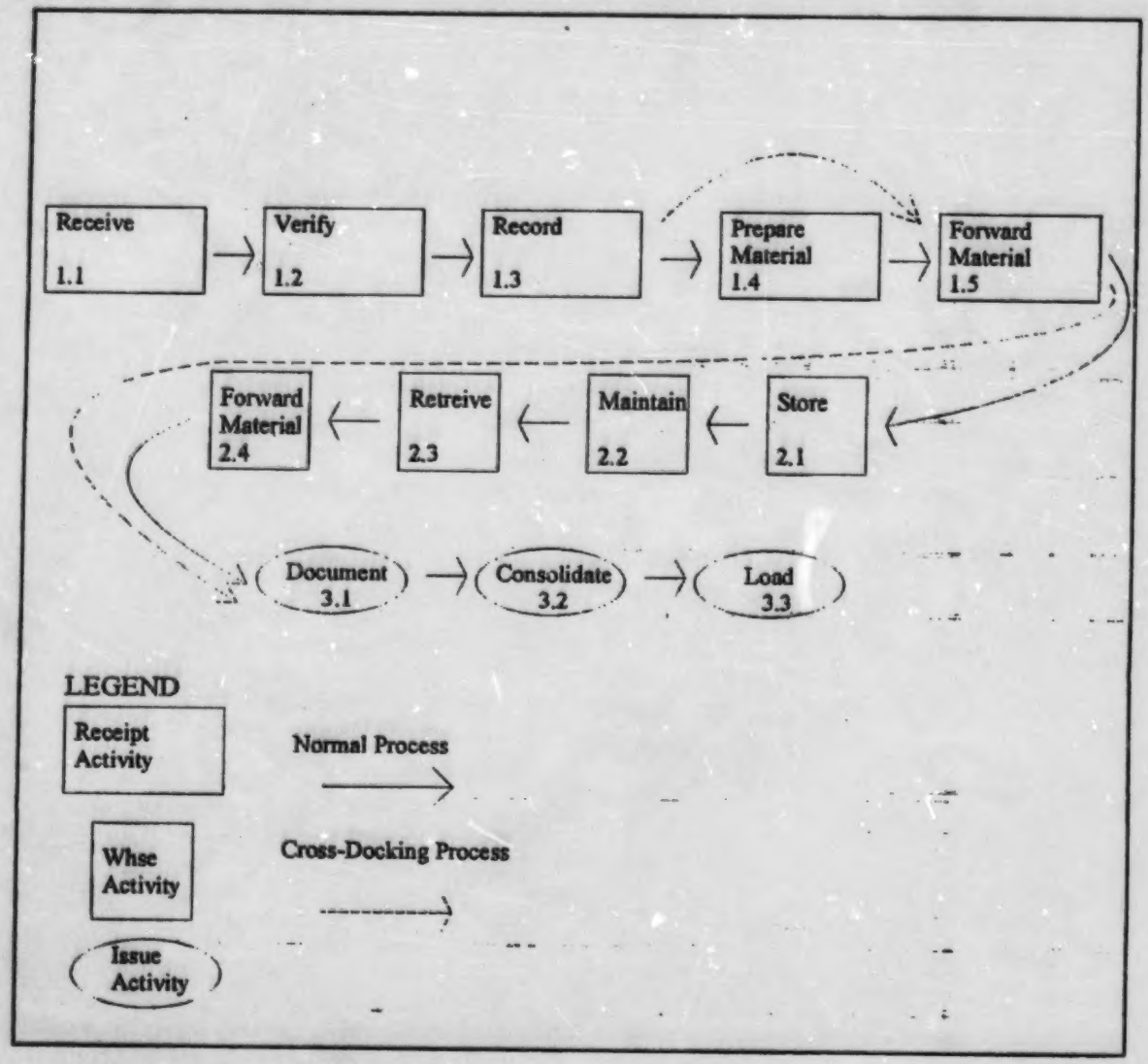

Figure 3: 25 CFSD Cross-Docking Process Flow

15. There are several advantages to instituting cross-docking at 25 CFSD. The material handling process for PDO material shortens the receipts process and eliminates the requirement for the warehousing staff to put the material away and retrieve it for issue. This shortened process results in reduced workloads in the affected areas. Cross-docking allows PDO material to bypasses the warehouse. This reduces the amount of warehouse space required for storage, eliminates the need to care for the material while it is in the warehouse and reduces the opportunities for material to be lost, damaged or stolen. The other major advantage of cross-docking is the affect that it can have upon customer service. Material that is PDO is required elsewhere before it arrives at 25 CFSD. Typically PDO's exist to satisfy specific user needs or to replenish stock levels elsewhere in the supply chain. By employing cross-docking to satisfy PDO demands, the delay in passing the material to it's final destination is minimized. This is clearly an improvement in customer service.

16. The advantages of cross-docking are countered by several disadvantages. The receipts process will become less efficient. Extra steps must be inserted in the receipts process for all shipments to accommodate cross-docking. The requirement for a second material handling process will likely result in interruptions of the material flow. This is due to each processing method having it's own bottlenecks. Since the same network will processes all material, each bottleneck will affect the flow of material regardless of the processes it is following. This will be especially problematic when only part of a shipments is PDO and it must be split between the two receipt processes. Cross-docking will also increase the shipping space required to hold low priority cross-docked material awaiting shipment.

VI. CROSS-DOCKING STRATEGIES

17. Analysis of the current material process at 25 CFSD revealed that all of the essential elements for cross-docking are not present. The state of the information technology in 25 CFSD and the CFSS does not allow PDO deliveries to be identified automatically. The arrival dates of specific deliveries are not known in advance so receipts must be performed in a reactive rather than a proactive manner. Therefore when shipments arrive, a query must be placed on the national inventory control system for every item being considered for cross-docking in a shipment to identify what PDO's exist for the material arriving. This procedure can be time consuming and increases the "cost" of cross-docking at 25 CFSD. The physical layout of 25 CFSD may not be appropriate for cross-docking. A reorganization of the

warehouse would be required to accommodate the cross-docked material. This change to the depot configuration could affect the productivity of the current material handling process. A material flow simulation would be required to identify the impact of changing the depot configuration. Additionally it was suspected that 25 CFSD might not receive a material flow that was conducive to cross-docking. Many of the potential benefits from cross-docking could be undermined by low cross-docking volume. As a result of these concerns an analysis of cross-docking opportunities for different cross-docking strategies was designed. There were four strategies considered. The cross-docking strategies were devised based upon the material processing analysis and the characteristics of the material being processed.

18. **Full Cross-docking**. The first strategy considered was full cross-docking. This strategy requires that all PDO material regardless of its characteristics be cross-docked. All items being receipted into the depot are considered for cross-docking. Any item that are PDO will be cross-docked. This strategy allows the maximum costs and benefits of cross-docking to be identified.

19. **High Priority PDO Cross-Docking**. The CFSS employs a Material Priority Code (MPC) system to identify the urgency of the requirement for material. Annex A provides an explanation of the MPC system. Material handling and shipping decisions are made based upon the MPC of a demand. A demand with a high MPC is urgently required by a customer for a specific purpose. Extraordinary efforts are made to satisfy these requirements as soon as possible. If this demand is PDO then there is no visible stock[3] elsewhere in the CFSS to satisfy the demand. The satisfaction of these demands in minimum time contributes significantly to customer satisfaction. A demand which results in a low MPC PDO is typically a requirement to replenish stocks elsewhere in the supply chain. The timely satisfaction of these demands is less important to customer satisfaction and would not normally necessitate extraordinary material handling procedures. Under this strategy only PDO material with a high material priority code (0X, 01, or 02A) is cross-docked. Only a portion of the material processing costs and benefits from cross-docking are achieved under this strategy. All of the significant customer service advantages are retained however.

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3 Some stock holdings in the CFSS are not subject to redistribution. They are referred to as not being visible.

20. **Large Weight, Volume, or Quantity**. Shipments that are processed at 25 CFSD exhibit a wide range of physical characteristics. Items can be as large as a vehicle or as small as a circuit board. They can weigh thousands of kilograms or as little as one gram. They can also be received in a wide range of quantities. Because of this wide variance of physical characteristics among shipments the resources required to process the shipments at the depot also varies. The shipments that require the most resources to process them are the ones with items that are large in weight, volume or quantity. These shipments require special material handling methods and different warehousing facilities. They often consume large amounts of processing time due to the requirement to verify and handle the large quantities received or issued. Since these shipments are large resource consumers in the normal material handling process, they are likely to create the greatest resource savings if cross-docked. Therefore a strategy that targets only large weight, volume or quantity PDO shipments for cross-docking was devised. The strategy uses minimum weight, volume, or quality thresholds for PDO shipments to be selected for cross-docking.

21. The cross-docking selection thresholds for weight and volume were 15.9 kilograms and 55199 cubic centimetres respectively. These values were selected since they are also used to determine if an item can be handled using the monorail transportation and sorting system. It was decided that items that are not admissible to the monorail use more resources during the warehousing and issue stage than lighter items or smaller ones. Therefore those are the heavy or large items that need to be targeted for cross-docking.

22. The cross-docking selection quantity threshold was set at 24. This rather arbitrary value was selected based upon expert opinion at 25 CFSD. It was pointed out that quantities in excess of two dozen are usually stored as case lots and their cumulative weight and volume often exceed the monorail admissibility criteria. The other factor that helped determine quantity threshold was the time required to physically count and handle the items during material processing. Obviously the larger the quantity of items to be counted and handled the longer the processing time. The avoidance of warehousing and retrieving quantities of items in excess of 24 offers significant resource savings. This strategy provides a portion of the potential resource savings and reduces the costs of cross-docking since all material need not be considered for cross-docking. This strategy only achieves a portion of the possible customer service improvement however.

23. **Total Quantity PDO**. Many shipments that are received have items with a portion of the total quantity PDO. When full cross-docking is in effect the shipment must be split during the receipt processing so that the PDO portion of the shipment is handled using the cross-docking process and the remainder of the shipment is handled using the conventional process. The splitting of the shipments between the two processes was considered to be wasteful of resources and a potential bottleneck in the receipt process. Therefore the strategy of only cross-docking shipments with the total quantity received PDO was considered. Shipments with only a portion of their quantitiy cross-dockable is processed as if a PDO does not exist. This strategy reduces the costs of cross-docking significantly but it only achieves a portion of the benefits also.

VII. SIMULATION RESULTS

24. Analysis of the 1995 transaction history file revealed that 25 CFSD performed 208,269 receipts and 137,494 issues during the year. The receipts figure is higher than other years due to the depot consolidation project. When receipts from other DND agencies are disregarded the quantity of receipts for 1995 drops to 14941. It is not possible to determine whether an issue is performed for material receipted from another DND agency. Therefore the effect that depot consolidation had on issue activity is not known.

25. The performance of the cross-docking strategies were assessed with regard to the frequency of cross-docking and the number of times the full quantity received was cross-docked. These measures indicate the impact that each cross-docking strategy would have on 25 CFSD material flow.

26. This cross-docking frequency measure was calculated for both receipt and issue activities. The quantity of receipts cross-docked represents the number of times that steps 1.4, 2.1 and 2.2 from Figure 1 were bypassed due to cross-docking. This measure is important because it identifies how often the receipts process used the cross-docking material processing method (fig 3) under each of the cross-docking rules and it identifies a portion of the resource savings due to cross-docking. The quantity of cross-docked issues represents the number of times steps 2.3 and 2.4 from Figure 1 were avoided due to cross-docking. It identifies the remainder of the resource savings due to cross-docking and it is an indicator of

how often customer service could have been improved [4]. These measures are not identical since the receipt of a shipment of an item can often trigger several issue instructions to satisfy demands from different customers for the same type of item.

27. The frequency with which total quantities received were cross-docked was also measured. This is a measure of how often pure cross-docking was performed. Since the total quantity was cross-docked, only one material processing method was used. These occasions represent times when the full benefits of cross-docking were achieved and the disadvantages of performing two material processing methods for one shipment were avoided.

28. Table I contains the simulation results when all 25 CFSD receipt and issue transactions for 1995 were considered. The table lists the performance measures across the top of the table by gross number of cross-docking events and by percentage. The cross docking strategies considered are listed down the second column of the table.

TABLE I
CROSS-DOCKING SIMULATION RESULTS

STRATEGY		PERFORMANCE MEASURE					
		PDO RECEIPT		PDO ISSUE		FULL QTY ISSUE	
		Qty	%	Qty	%	Qty	%
	ALL PDO	3272	1.6	5210	3.8	1939	1.0
	LARGE WT, VOL, OR QTY	2487	1.2	3869	2.8	1473	0.7
	HIGH MPC	563	0.2	770	0.6	348	0.2
	FULL QTY PDO	1939	0.9	2639	1.9	1939	0.9

[4] Customer service is only improved if the material is actually shipped to the customer earlier due to cross-docking. Changing the material handling method without changing the shipping policy for low priority material will not result in improved customer service.

29. Full cross-docking represents the maximum possible cross-docking frequency. With PDO receipts of 3273 or 1.6 percent of the total receipts processed and 5210 or 3.8 percent of total issues processed the potential for cross docking at 25 CFSD is significantly lower than many commercial warehousing operations. This means that the addition of extra steps in the receipts process to identify PDO shipments will be wasted effort 97.3 percent of the time. A high portion of the receipts that are PDO have the total quantity due out. This means that only 0.7 percent of the shipments received will have to be deconsolidated during shipping and processed using the two material processing methods.

30. Cross-docking for large weight, volume or quantity PDO shipments would occur 1.2 percent of the time at the receipts section and 2.8 percent of the time at issues. Only 0.5 percent of the shipments received would employ both material processing methods. It should be noted that the weight and volume information on some material was unavailable. In the absence of data, items were assigned zero for weight and zero for volume. They were therefore not selected for this cross-docking method based upon their weight or volume. This means that the frequency of cross-docking using this strategy is likely understated. It is probably higher than stated in Table I for this strategy but not as high as the full cross-docking method results. These results suggest that a large portion of all possible cross-docking opportunities could be taken advantage of without subjecting all receipts to PDO queries. This can be accomplished by only considering shipments with large weight, volume or quantity ship characteristics for cross-docking. This strategy reduces the frequency of bottlenecks in the receipt process but achieves the large resource savings due to cross-docking.

31. The frequency of cross-docking occurrences for high priority PDO's was extremely low. Since cross-docking of high MPC PDO's results in better customer service, the potential for achieving better customer service through cross-docking is insignificant. Another conclusion that can be drawn from the high MPC cross-docking data is the impact on the shipping section of full cross-docking. Since only 0.6 percent of all cross-docking issues are satisfying high MPC demands, the remaining cross-docked material under full cross-docking would have a significant dwell time in shipping. This is due to the once weekly shipment of low priority material to each geographic region. The result of this occurrence would be a requirement for more space for the shipping section.

32. The results of the full quantity PDO simulation indicates that more than half the PDO's that exist are for the full quantity received and that those PDO's account for half of the total PDO issues. This means that the full quantity PDO strategy would miss 1333 possible PDO receipts and 2571 possible PDO issues. However the requirement to process shipments of items over both processes would be avoided.

33. Table II contains the simulation results when depot consolidation activity is disregarded. The number of receipts processed that were not considered part of depot consolidation was 14941 or 7 percent of the total receipt activities. The rule used to discard transactions for these simulation runs was too stringent. By excluding all receipt activity from other DND agencies, an unknown amount of legitimate supply activity that had nothing to do with the depot consolidation project was disregarded. The only remaining receipt activity for this simulation is receipts from commercial firms. Unfortunately there was no other way to differentiate between these two types of receipts from DND agencies. Based upon this knowledge, it is likely that the performance measures stated as percentages in Table II are higher than they should be.

TABLE II
CROSS-DOCKING SIMULATION RESULTS WITHOUT CONSOLIDATION ACTIVITIES

STRATEGY		PERFORMANCE MEASURE					
		PDO RECEIPT		PDO ISSUE		FULL QTY ISSUE	
		Qty	%	Qty	%	Qty	%
	ALL PDO	728	4.9	1332	N/A	656	4.4
	LARGE WT, VOL, OR QTY	646	4.3	945	N/A	579	3.9
	HIGH MPC	196	1.3	209	N/A	170	1.1
	FULL QTY PDO	656	4.4	707	N/A	656	4.4

34. Despite the limitations of the data in Table II, it is obvious that there exists a greater cross-docking opportunities when receipts from DND agencies are disregarded. Almost 5 percent of commercial receipts have part of their quantity PDO and about 4.4 percent have their total quantity PDO. Additionally high MPC PDO's which can improve customer service when cross-docked account for 26 percent of all PDO's. These results suggests that a cross-docking strategy just for commercial receipts might be the most effective. By attempting to cross-dock only commercial receipts, all receipts from DND agencies will follow the process outlined in Figure 1 regardless of the receipts PDO status. This means that only commercial receipts will be subjected to alternative processing outlines in Figure 3.

VIII. CONCLUSIONS

35. The results of this project have revealed that 25 CFSD is not an ideal candidate for cross-docking. It does not possess the necessary WMIS capabilities to facilitate efficient cross-docking and it could not accommodate full cross-docking without reconfiguring the warehouse. Additionally, the material flow through 25 CFSD is not ideal for cross-docking. Commercial warehousing operations that are gaining full benefits from cross-docking are handling 70 % of their shipping volume in this manner. The most promising cross-docking scenario for 25 CFSD does not even handle 5 % of the total volume. Normally this would not be justify the institution of a cross-docking policy due to the high cost and low benefits derived from it. The creation of a cross-docking strategy for high weight, volume or quantity shipments might be worth considering if the resource savings achieved by cross-docking these shipments outweighs the loss in efficiency created by introducing a second material handling process.

36. An alternative approach that should be considered is the employment of a cross-docking strategy just for shipments from commercial agencies Once again the cost in reduced material processing efficiency must be weighed against the resource savings that may be achieved at 25 CFSD.

37. To further investigate the potential of these two cross-docking methods a cost benefit analysis would be required. If the environment at 25 CFSD changes, cross-docking might become a more attractive option. For example when the staff of 25 CFSD can find out details about shipments before they arrive and the WMIS has the ability to identify PDO shipments without adding steps to the receipts process, cross-docking even in low quantities may be viable. Until these technical and procedural problems are resolved, the full benefits of cross-docking cannot be achieved.

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ANNEX A
LOGORT RN-9701
MARCH 1997

MATERIAL PRIORITY CODES [9]

Purpose To indicate to the supplier the urgency of the requirement to the demander .

Application This code is assigned by the demand originator to his/her initial request and is shown on all subsequent transactions pertaining to it.

MPC CODE	EXPLANATION
0X	Immediate operational requirement.
01	Urgent - having a required delivery date (RDD) of 2 to 7 days
02A	Urgent - having a RDD of 7 days or less
02B	Urgent - having a RDD of 8 to 15 days.
03	Routine - having a RDD of 16 to 60 days with a specific date.
04	Routine - having a RDD of 30 days (stock replenishment)

ANNEX B
LOGORT RN-9701
MARCH 1997

SIMULATION ALGORITHM

```
INITIALIZE DATA
WHILE NOT END OF DATA FILE DO
BEGIN
    READ RECEIPTS FOR DAY INTO RECEIPTS LIST
    ADD ISSUES FOR DAY + 1 TO ISSUES LIST
    FOR EVERY RECEIPT DO
    BEGIN
        SEARCH ISSUES LIST FOR ISSUES WHICH MATCH PDO RULE
        IF MATCHING ISSUE FOUND THEN
        BEGIN
            UPDATE PDO RECORDS
        END
    END
    REMOVE ALL RECEIPTS FROM RECEIPTS LIST
    REMOVE ISSUES FOR DAY FROM ISSUES LIST
END
REPORT PDO RESULTS
```

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The problem of identifying an appropriate cross-docking strategy for 25 Canadian Forces Supply Depot (CFSD) was investigated. Potential cross-docking strategies were developed and evaluated. Employing 1995 supply transaction data, simulations were conducted to identify the impact of the cross-docking strategies on 25 CFSD. It was concluded that cross-docking is not practical at 25 CFSD due to infrequent cross-docking opportunities and physical limitations at the depot which reduce the efficiency of cross-docking

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